simply places a very small theodolite provided with an index arm, reading to 1/10 degree, directly over the origin of the coordinates on the drawing paper, and sights upon a divided rule supported vertically. Better still would it be to set the small theodolite at the reading, for any moment, of the large instrument with which the balloon is observed, and then bring the mark on the divided rule corresponding to the altitude at that moment, into the line of sight of the theodolite. The sharp point marking the location of the foot of the rule would then indicate the position of the vertical projection of the balloon or its nadir. There is no doubt that, with a little practise, the path of the balloon could be graphically plotted in a few minutes by this method. However there would be a certain amount of difficulty when the angular altitude became very great, and in general for the first few points of every path traced. Whichever method be selected, the observer will have to accustom himself to carrying out the measurements in a definite routine and an intelligible way. I foresee the time when the watchman of many a meteorological observatory will perform these duties in the same apathetic way in which he now goes about the routine of the periodic observations which today constitute the observational portion of the observatory duties.

At first, to be sure, one will regard the reduction of each new observation as a *novum atque inauditum*, as regards its results. Yet even if such regular observations and measurements are inaugurated at only a single station, the expense and trouble entailed would be richly repaid, especially at localities having fine weather, by the incomparably more accurate knowledge thus gained, as compared with our present knowledge concerning changes in the direction and velocity of the wind with increasing altitude. What splendid support such a series of measurements would afford to works like the admirable investigations into the circulation of the atmosphere by H. Hildebrandsson[6]. How much more excellent support would be furnished if we had simultaneous observations from a number of stations. Many, and perhaps those precisely who have the progress of meteorology most at heart, will be somewhat skeptically inclined toward a proposal for new simultaneous international observations. Ever new demands, and where is the fulfilment of earlier promises?

In reply, it must first of all be emphasized that the present case does not seem to call for any special prearrangement or international preparation beyond an occasional arrangement among those actively interested so that the results may be published as soon as possible. It is superfluous to make any special agreement as to dates for the flight trials, since the observations are to be made on every day that is in any degree favorable for them, and hence they are necessarily as simultaneous as it is possible for them to be.

To those whose past experience induces a certain hesitancy toward these new proposals I would present the following considerations. In the case of the international simultaneous observations in the free air as thus far carried out, with which one mentally connects my present proposition, we are dealing with measurements which demand extraordinary care if the quantities that it is intended to measure are to be truly comparable. This can not be secured thru the improvement of the instruments alone. The sources of error are so numerous and so great that unless each and every point is taken account of in the handling of the instruments and the calculation of the results, the resulting uncertainties will exceed the very differences which it is desired to determine. Unfortunately, it has also been found that the requisite many-sided painstaking qualities and the delicate sense of the physicist are not possest by every one, and cannot be purchased with the instrument from the manufacturer. If then, and chiefly for these reasons, the above-mentioned international arrangements have not yet met with the unqualified success which was once expected of them, and if the more accurate discussion of their results has been so far delayed precisely because they are believed to be not perfectly comparable—still similar doubts should not be transferred to the simpler simultaneous observations which I here propose. To be sure, even these observations demand a certain degree of care, as do all that are to be of any value at all. But the sources of error are much more limited and the possible errors are of much smaller magnitude as compared with the quantities to be measured. The procedure is indeed a right simple one: determine the buoyancy or ascensional force of a balloon, sight the telescope, read a clock and a coarsely divided circle; all these manipulations demand only a fairly delicate physical sense (the light touch and sharp eye of a good observer); and if they are carried out by a man who is at all conscientious in his work can not well fail to be sufficiently well executed. One is therefore justified in assuming that, in general, we shall not have to deal with results which may be accepted "only with great caution".

The measurements under discussion possess the further advantage that the results can be deduced and applied immediately after the experiment, an advantage so much emphasized as attaching also to the otherwise very troublesome kite flights. Without indulging in unfounded hopes I seriously expect to find such pilot-balloon observations of some value in weather forecasting. It is true that the evidence for this is as yet lacking, because I have no materials on which to base the statement. General considerations, however, make it quite clear that precisely at the times of change from fair weather to rain, which are the special difficulties of the forecaster, there must occur changes in the upper circulation whose significance would thereby be learned. To all earnest, experienced forecasters, to all those who do not approach their predictions in the spirit of Kepler when casting horoscopes, but who would endeavor to attain the attainable, I would put this question: "Do you believe that in the presence of that sudden, recent change of weather the accurate knowledge of the wind's direction and velocity at levels of 5000 to 10,000 meters would have aided you in forecasting"? If the answer is "yes", then I would say that in the future this knowledge may be cheaply and readily secured. If the answer be "no", than I would ask: "What attainable data would be of help?"

For the present it is to be urgently recommended to all institutions and private students who are in any wise able to carry them out, that they inaugurate continuous and regular observations of pilot-balloon flights. The results will soon prove to have a purely scientific value and probably will also be of importance in forecasting.

[6] I refer particularly to the second part of his "Rapport sur les observations internationales de nuages", Upsala, 1905.

HERMAN DECLERCQ STEARNS.

By G. A. CLARK, Secretary Leland Stanford Junior University, Palo Alto, Cal. Dated November 15, 1907.

Herman Declercq Stearns, associate professor of physics in Leland Stanford Junior University, died of tuberculosis on October 21, after an illness of four years. Professor Stearns was born in Joliet, Ill., September 14, 1865. His preparatory education was gained in the public schools of Joliet. After graduating from the high school he became a teacher, and taught for some time in the Joliet High School, later becoming principal of the public school at Lake Forest, Ill. He entered Lake Forest University with the class of 1892, but left in 1891 to enter Stanford University, which opened that year. He took his A. B. degree at Stanford in 1892, and his A. M. degree in 1893. He was made instructor in physics in the university in 1893, assistant professor in 1896 and associate professor in 1900. He was a student in the University of Berlin during the academic year 1897–98, where he gave most of his time to the study of meteorology under von Bezold.

Professor Stearns excelled especially as a teacher of physics. He published but few papers, principally on the phenomena of thunderstorms.[1] His best known piece of experimental work was in the determination of the magnetic susceptibility of water, the results of which were published in the Physical Review of January, 1902.

Professor Stearns was married in 1894 to Miss Florence Curry of Streator, Ill., who survives him.

THE LAGGING OF TEMPERATURE CHANGES AT GREAT HEIGHTS BEHIND THOSE AT THE EARTH'S SURFACE AND TYPES OF PRESSURE CHANGES AT DIFFERENT LEVELS.

By HENRY HELM CLAYTON, meteorologist of the Blue Hill Observatory. Dated Hyde Park, Mass., November 30, 1907.

By permission of Prof. A. Lawrence Rotch, director of the Blue Hill Observatory, I am able to publish, in advance of a more detailed discussion by me in the Annals of the Astronomical Observatory of Harvard College, a few results of interest derived from a study of the records obtained with sounding balloons launched from St. Louis, Mo.

One of the earliest facts disclosed by the records obtained in the free air with kites at Blue Hill was that changes of temperature occur earlier at heights of 500 to 1000 meters than at the earth's surface.[1] It had also previously been disclosed by a study of the observations on Mount Washington that changes of temperature usually occur earlier at the summit than at the base.[2] In a recent number of the MONTHLY WEATHER REVIEW,[3] Prof. C. H. McLeod proposes to predict weather changes from observations on Mount Royal, Montreal, which show the coming of weather changes earlier there than at low stations.

Long before the fact of the earlier coming of temperature changes at heights of 500 to 1000 meters had been established, it was inferred that a change of temperature would occur first in the upper air because the upper currents move so much faster and overflow those below. This assumption has been used for many theoretical explanations of thunderstorms, tornadoes, waterspouts, and even of general storms. However, the recent records obtained at St. Louis with sounding balloons, by the staff of Blue Hill Observatory, show that at all heights except within about 1000 meters of the earth, the temperature changes occur successively later with increasing height above the ground. This fact is best shown by the records for April and May, 1906, because this series of observations is more complete and for a longer interval than any other yet obtained at St. Louis. The balloons were liberated by Mr. S. P. Fergusson near sunset each day, and the highest point, varying between 3 and 15 kilometers, was reached between 7 and 9 o'clock. Records were obtained on every day from April 28 to May 19, with the exception of three days. These records make it possible to follow the changes of temperature from day to day at different heights. The temperatures on different days at successive heights of 5 kilometers are shown in Table 1, and the results are plotted in Fig. 1.

It is apparent from the table and from fig. 1 that maxima and minima in temperature occur very considerably later in the upper air than at the earth's surface. What appear to be similar maxima and minima at different levels are marked by similar numerals, *1*, *2*, *3*, etc., in fig. 1.

By comparing the temperature maxima and minima at the ground, 167 meters above sea level, with the maxima and minima at 10,000 meters, it is seen that the maxima and minima at 10 kilometers occur almost constantly about twenty-four hours later than at the ground. The observations are not in sufficient detail to show whether this retardation is gradual from level to level or occurs in irregular steps; but apparently the change is not gradual. The maximum marked *5* occurs simultaneously at 5000 and at 10,000 meters, but occurs there about a day later than at the ground. On the other hand the maximum marked *8* occurs simultaneously at the ground and at 5000 meters, but occurs a day later at 10,000 meters. However, as observations were taken only once a day it is not possible to follow any gradual shifting occupying only one day. The observations at the height of 15,000 meters were not sufficiently numerous to follow the changes easily, but apparently the irregular ranges of temperature at this height are very much less than at sea level. From May 2 to 10, inclusive, records were obtained at each level from the ground to 10 kilometers, and during part of this time there were records at 15 kilometers also. The means of the changes of temperature from one day to another at different levels are found to be as follows: at the ground, 6.0° C.; at 5 kilometers, 5.2°; at 10 kilometers, 7.1°; and at 15 kilometers, 2.9°. These results indicate that the irregular changes of temperature reach a maximum at 10 kilometers, and suddenly decrease at 15 kilometers. Between these two levels there is found a marked inversion of temperature in both Europe and America; the air at 15 kilometers is warmer than that at 13 to 14 kilometers, and it may be that the changes in temperature in the two strata have little in common.

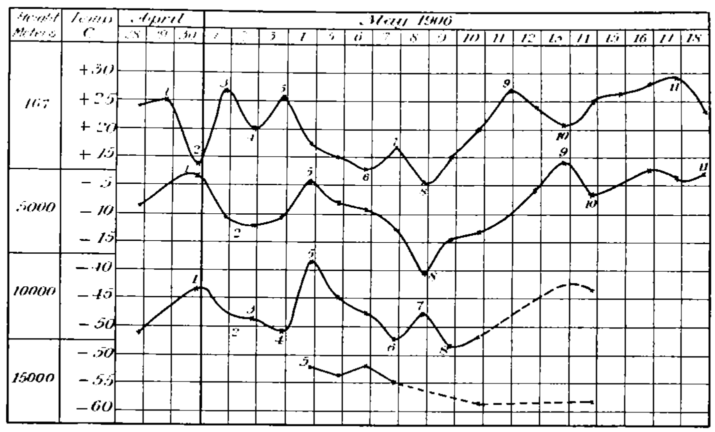

FIG. 1.—The temperatures at successive heights above sea level derived from records obtained with sounding balloons ascending from St. Louis, Mo., April and May, 1906.

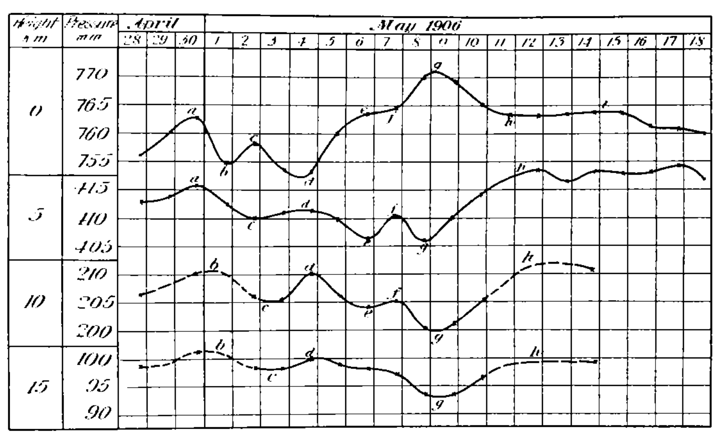

FIG. 2.—The pressures at successive heights above sea level derived from records obtained with sounding balloons ascending from St. Louis, Mo., April and May, 1906.

The mean pressures at different heights from sea level to 15 kilometers are given in Table 2. In obtaining these results

[1] See Monthly Weather Review, October, 1898, vol. 26, p. 452, "The effect of proximity to the sea on thunderstorm periods."

[1] See Blue Hill Meteorological Observatory Bulletin, No. 2, 1898, p. 2; also Annals of the Astronomical Observatory of Harvard College, vol. XLII, part I, 1897, p. 107.

[2] See American Meteorological Journal, vol. IV, p. 268, 1887.

[3] November, 1906, vol. XXXIV, p. 505–510.